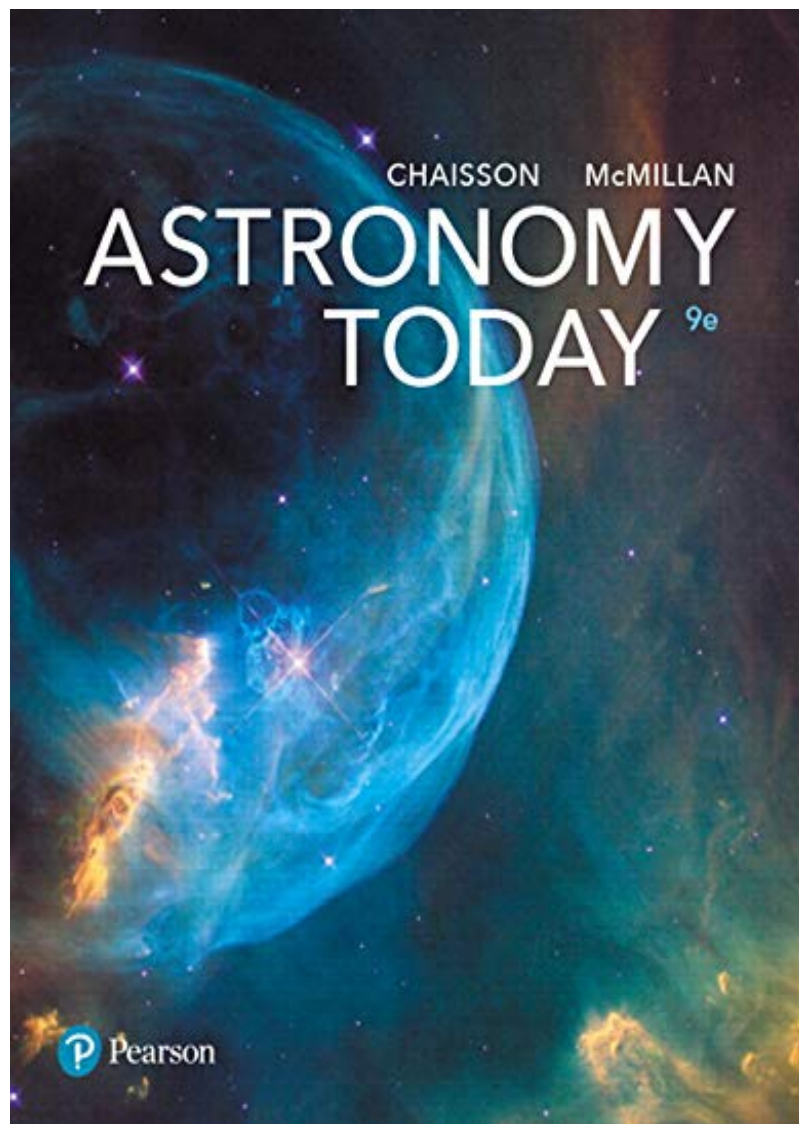


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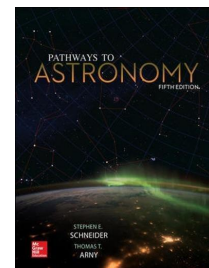


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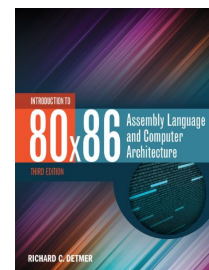
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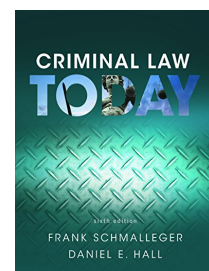
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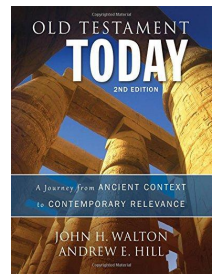
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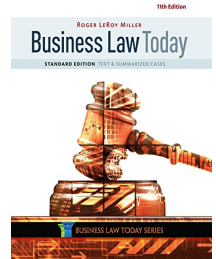
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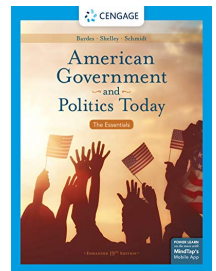
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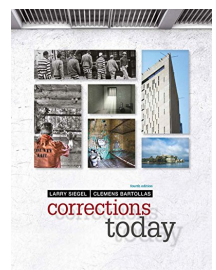
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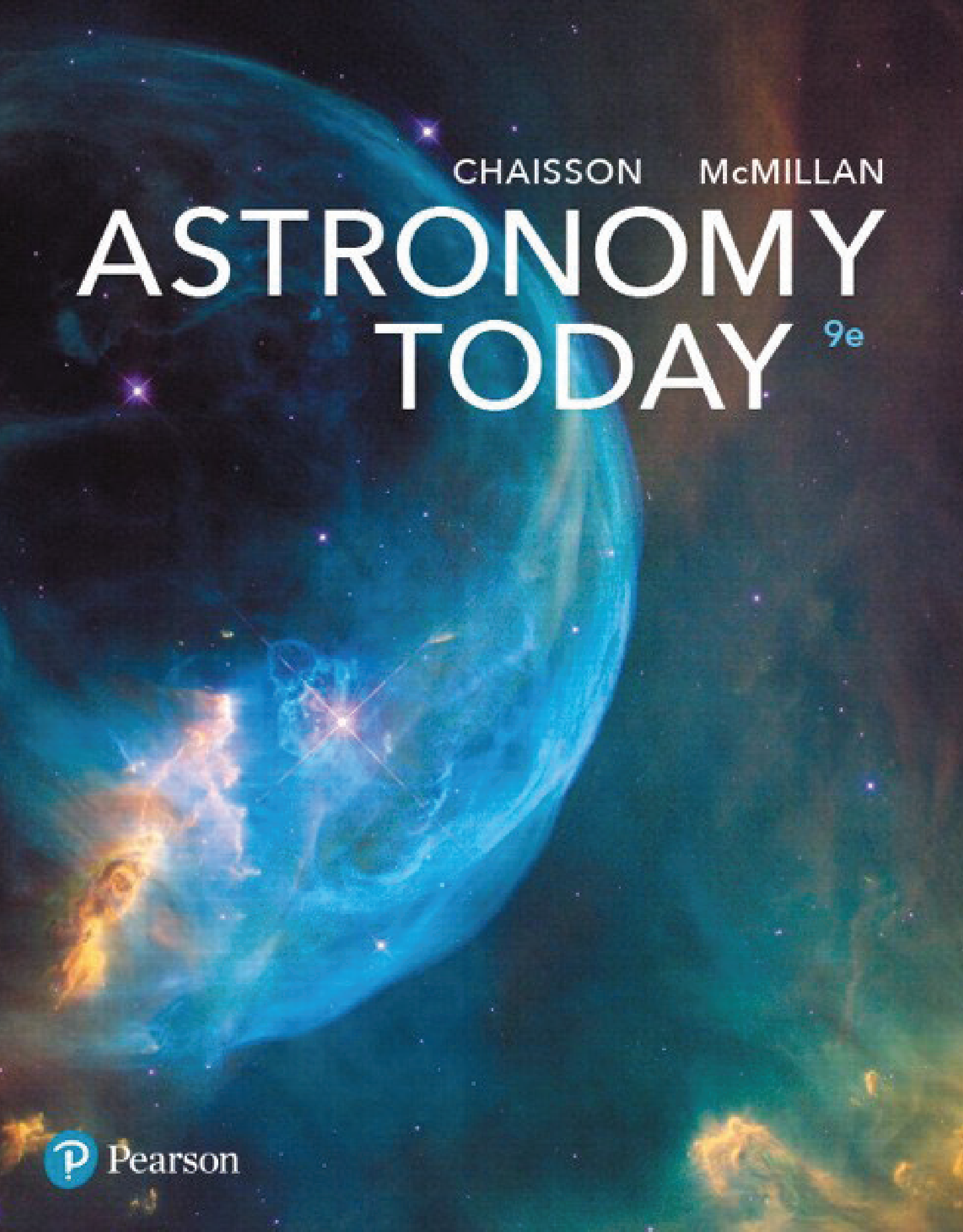
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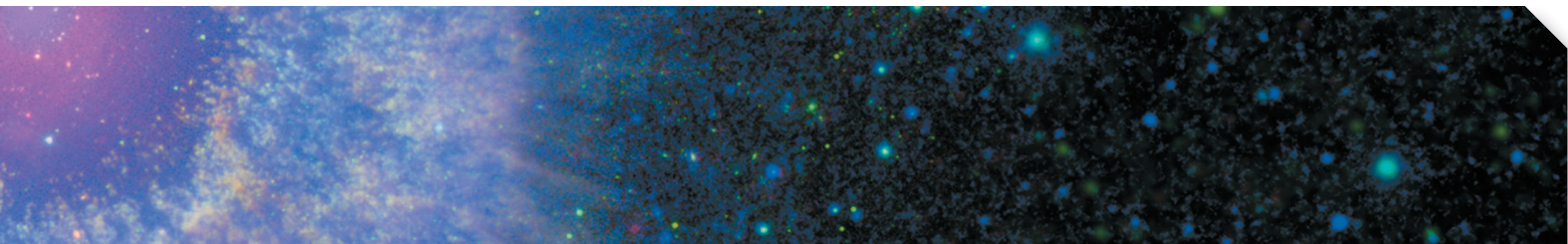
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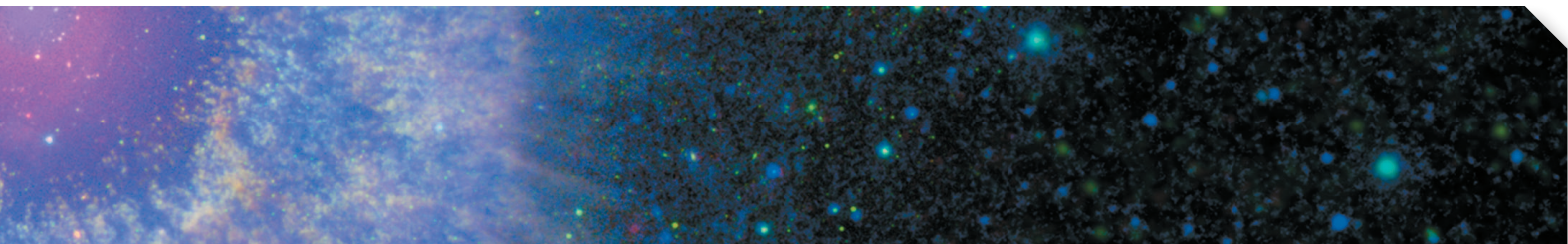
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PREFACE

Astronomy is a science that thrives on new discoveries. Fueled by new technologies and novel theoretical insights, the study of the cosmos continues to change our understanding of the universe. We are pleased to have the opportunity to present in this book a representative sample of the known facts, evolving ideas, and frontier discoveries in astronomy today.

Astronomy Today has been written for students who have taken no previous college science courses and who will likely not major in physics or astronomy. It is intended for use in a one- or two-semester, nontechnical astronomy course. We present a broad view of astronomy, straightforwardly descriptive and without complex mathematics. The absence of sophisticated mathematics, however, in no way prevents discussion of important concepts. Rather, we rely on qualitative reasoning as well as analogies with objects and phenomena familiar to the student to explain the complexities of the subject without oversimplification. We have tried to communicate the excitement we feel about astronomy and to awaken students to the marvelous universe around us.

We are very gratified that the first eight editions of this text have been so well received by many in the astronomy education community. In using those earlier texts, many teachers and students have given us helpful feedback and constructive criticisms. From these, we have learned to communicate better both the fundamentals and the excitement of astronomy. Many improvements inspired by these comments have been incorporated into this new edition.

Focus of the Ninth Edition

From the first edition, we have tried to meet the challenge of writing a book that is both accurate and approachable. To the student, astronomy sometimes seems like a long list of unfamiliar terms to be memorized and repeated. Many new terms and concepts are introduced in this course, but we hope students will also learn and remember how science is done, how the universe works, and how things are connected. In the ninth edition, we have taken particular care to show how astronomers know what they know, and to highlight both the scientific principles underlying their work and the process used in discovery.

New and Revised Material

Astronomy is a rapidly evolving field and, in the three years since the publication of the eighth edition of *Astronomy Today*, has seen many new discoveries covering the entire spectrum of astronomical research. Almost every chapter in the ninth edition has been substantially updated with new information.

Several chapters have also seen significant reorganization in order to streamline the overall presentation, strengthen our focus on the process of science, and reflect new understanding and emphases in contemporary astronomy.

In addition to updates throughout the text on the numbers and properties of the many astronomical objects, the many substantive changes include:

- New discussion in Chapter 5 of next-generation telescopes and high-resolution astronomy.
- Updated information and imagery in *Discovery 5-1* on the ALMA array.
- New discussion in Chapter 8 of ice on the Moon.
- Additional coverage in Chapter 8 of Mercury's surface and interior based on *Messenger* data.
- New discussion in Chapter 10 of the depletion of the Martian atmosphere.
- Expanded coverage in Chapter 10 of the *Curiosity* rover on Mars and its findings so far.
- Update in Chapter 11 on the changing appearance of Jupiter's Great Red Spot.
- New material in Chapter 11 on the 2016 *Juno* mission.
- Updated discussion in Chapter 11 of the internal structure of Ganymede.
- New discussion in Chapter 12 of storms on Saturn.
- Expanded coverage in Chapter 12 of lakes and other features on the surface of Saturn's moon Titan.
- Additional material in Chapter 12 on Saturn's moon Enceladus.
- Update in Chapter 13 on the return of Neptune's Dark Spot.
- New coverage in Chapter 14 of the *Dawn* mission to Ceres.
- Extensive discussion in Chapter 14 of the *Rosetta* mission to comet 67 P/Churyumov-Gerasimenko.
- Completely revised presentation of Pluto in Chapter 14 based on data from the *New Horizons* mission.
- Updated and rewritten presentation in Chapter 15 of exoplanet searches and properties.
- New material in Chapter 15 on direct imaging as an exoplanet detection technique.
- Expanded discussion in Chapter 15 of exoplanet composition.
- Presentation in new *Discovery 15-1* of gravitational microlensing as an important exoplanet detection technique.
- Updated discussion in Chapter 15 of habitable zones and planetary systems in star clusters.

- Additional material in *Discovery 16-1 on the Solar Dynamics Observatory*.
- Substantially improved discussion and imagery in Chapter 16 of the sunspot cycle.
- New coverage in Chapter 17 on the *GAIA* astrometric mission.
- Additional material in *Discovery 19-1* on brown dwarfs, clarifying the distinction between brown dwarfs and planets.
- Improved text and imagery in Chapter 19 on the observational evidence for various stages of star formation: ALMA imagery of protostellar collapse; *HST* observations of protoplanetary disks.
- Improved simulations of star cluster formation in Chapter 19.
- Expanded discussion in *Discovery 20-2* of mass loss from giant stars.
- Emphasis in Chapter 22 of the connection between hypernovae and black holes.
- Expanded treatment in *Discovery 22-1* of relativity and time dilation.
- Rewritten discussion of gravitational radiation in *Discovery 22-1*, including extensive coverage of the 2015 LIGO detections.
- Reconsideration in Chapter 22 of the existence of black holes, in the light of the new LIGO findings.
- New coverage in Chapter 23 of the “X” in the Milky Way bulge and its implication for our Galaxy’s history.
- Expanded material in Chapter 23 on the “S stars” in the Galactic center and energetic outflows from the Galactic center into the halo.
- Updated discussion of extremophilic life in Chapter 28.
- Consistent distance scales in all figures, helping students gain an understanding of the vastness of the universe.
- Numerous replacement images for currency and clarity, and updated art throughout the text.

The Illustration Program

Visualization plays an important role in both the teaching and the practice of astronomy, and we continue to place strong emphasis on this aspect of our book. We have tried to combine aesthetic beauty with scientific accuracy in the artist’s conceptions that adorn the text, and we have sought to present the best and latest imagery of a wide range of cosmic objects. Each illustration has been carefully crafted to enhance student learning; each is pedagogically sound and tied tightly to the nearby discussion of important scientific facts and ideas. This edition contains more than 100 revised figures that show the latest imagery and the results learned from them.

Compound Art It is rare that a single image, be it a photograph or an artist’s conception, can capture all aspects of a complex subject. Wherever possible, multiple-part figures are used in an attempt to convey the greatest amount of information in the most vivid way:

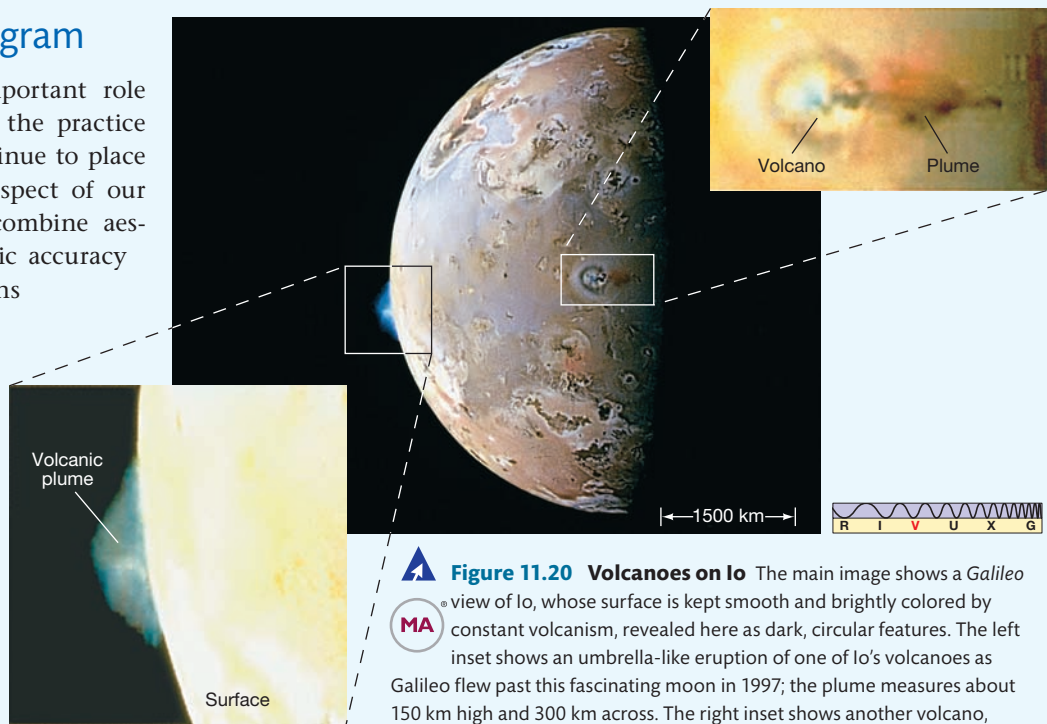


Figure 11.20 Volcanoes on Io The main image shows a *Galileo* view of Io, whose surface is kept smooth and brightly colored by constant volcanism, revealed here as dark, circular features. The left inset shows an umbrella-like eruption of one of Io’s volcanoes as *Galileo* flew past this fascinating moon in 1997; the plume measures about 150 km high and 300 km across. The right inset shows another volcano, this one face-on, where surface features here are resolved to just a few kilometers. (NASA)

- Visible images are often presented along with their counterparts captured at other wavelengths.
- Interpretive line drawings are often superimposed on or juxtaposed with real astronomical photographs, helping students to really “see” what the photographs reveal.

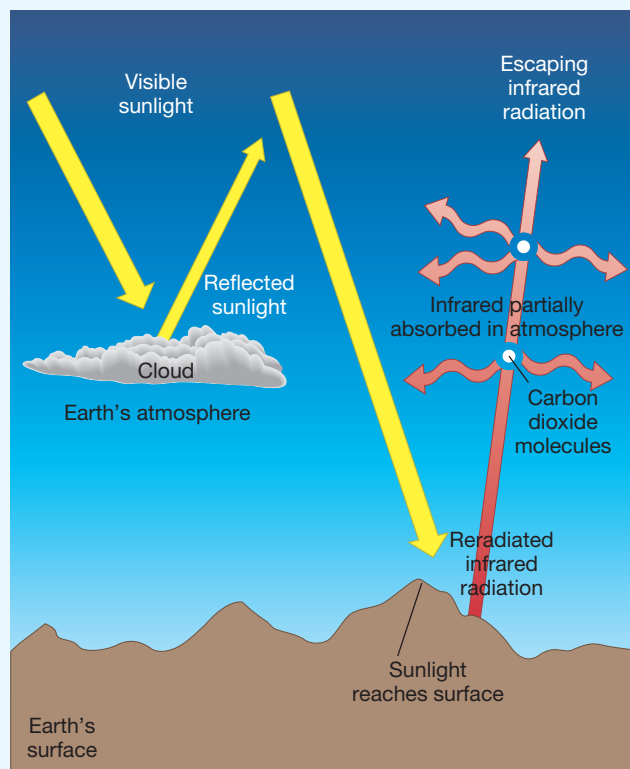


Figure 7.5 Greenhouse Effect Sunlight that is not reflected by clouds reaches Earth's surface, warming it up. Infrared radiation reradiated from the surface is partially absorbed by carbon dioxide (and also water vapor, not shown here) in the atmosphere, causing the overall surface temperature to rise.

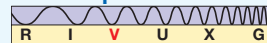
- Breakouts—often multiple ones—are used to zoom in from wide-field shots to close-ups so that detailed images can be understood in their larger context.

Figures and Photos Icons throughout the text direct students to dynamic, interactive versions of art and photos on MasteringAstronomy®. Using online applets, students can manipulate factors such as time, wavelength, scale, and perspective to increase their understanding of these figures.

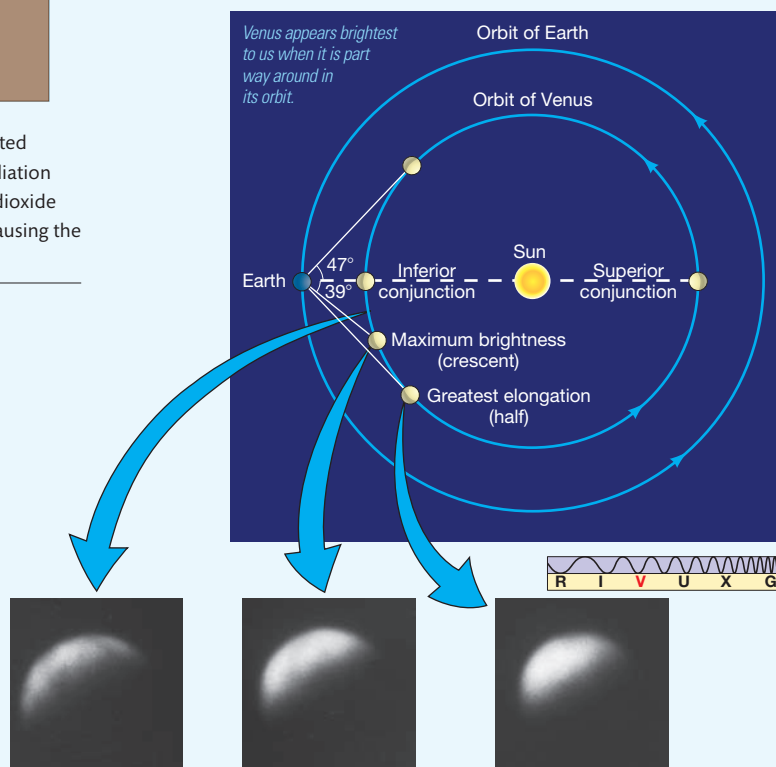
NARRATED Figures Narrated Figures are brief videos that step students through complex figures from the text, expanding students' understanding of fundamental concepts in a presentation that includes narration, enhanced visuals, and one to two embedded questions, followed by short, one- to two-question Mastering activities that are graded. They mirror how an instructor might present a topic in class and can be assigned as homework, self-study, or as part of a pre-lecture program.

Figure Annotations The ninth edition incorporates the research-proven technique of strategically placing annotations (which always appear in **blue type**) within key pieces of art, fostering students' ability to read and interpret complex figures, focus on the most relevant information, and integrate written and visual knowledge.

Full Spectrum Coverage and Spectrum Icons



Astronomers exploit the full range of the electromagnetic spectrum to gather information about the cosmos. Throughout this book, images taken at radio, infrared, ultraviolet, X-ray, or gamma-ray wavelengths are used to supplement visible-light images. As it is sometimes difficult (even for a professional) to tell at a glance which images are visible-light photographs and which are false-color images created with other wavelengths, each photo in the text is accompanied by an icon that identifies the wavelength of electromagnetic radiation used to capture the image.



NARRATED Figure 9.2 Venus's Brightness Venus appears full when it is at its greatest distance from Earth, on the opposite side of the Sun from us (superior conjunction). As its distance decreases, less and less of its sunlit side becomes visible. When closest to Earth, it lies between us and the Sun (inferior conjunction), so we cannot see the sunlit side of the planet at all. Venus appears brightest when it is about 39° from the Sun. (Compare Figure 2.12.) (Insets: UC Regents/Lick Observatory)

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Exploring the Variety of Random Documents with Different Content

allowance being made for the readier capacity of chosen and practised organs. Hence the beauties, concords, and eloquences of the female form were never without their effect upon Christopher, a born musician, artist, poet, seer, mouthpiece-whichever a translator of Nature's oracles into simple speech may be called. The young girl who had gone by was fresh and pleasant; moreover, she was a sort of mysterious HANDlink between himself and the past, which these things were vividly reviving in him.

The following week Christopher met her again. She had not much dignity, he had not much reserve, and the sudden resolution to have a holiday which sometimes impels a plump heart to rise up against a brain that overweights it was not to be resisted. He just lifted his hat, and put the only question he could think of as a beginning: 'Have I the pleasure of addressing the author of a book of very melodious poems that was sent me the other day?'

The girl's forefinger twirled rapidly the loop of braid that it had previously been twirling slowly, and drawing in her breath, she said, 'No, sir.'

'The sender, then?'

'Yes.'

She somehow presented herself as so insignificant by the combined effect of the manner and the words that Christopher lowered his method of address to her level at once. 'Ah,' he said, 'such an atmosphere as the writer of "Metres by E." seems to breathe would soon spoil cheeks that are fresh and round as lady-apples-eh, little girl? But are you disposed to tell me that writer's name?'

By applying a general idea to a particular case a person with the best of intentions may find himself immediately landed in a quandary. In saying to the country girl before him what would have suited the mass of country lasses well enough, Christopher had offended her beyond the cure of compliment.

'I am not disposed to tell the writer's name,' she replied, with a dudgeon that was very great for one whose whole stock of it was a

trifle. And she passed on and left him standing alone.

Thus further conversation was checked; but, through having rearranged the hours of his country lessons, Christopher met her the next Wednesday, and the next Friday, and throughout the following week-no further words passing between them. For a while she went by very demurely, apparently mindful of his offence. But effrontery is not proved to be part of a man's nature till he has been guilty of a second act: the best of men may commit a first through accident or ignorance-may even be betrayed into it by over-zeal for experiment. Some such conclusion may or may not have been arrived at by the girl with the lady-apple cheeks; at any rate, after the lapse of another week a new spectacle presented itself; her redness deepened whenever Christopher passed her by, and embarrassment pervaded her from the lowest stitch to the tip of her feather. She had little chance of escaping him by diverging from the road, for a figure could be seen across the open ground to the distance of half a mile on either side. One day as he drew near as usual, she met him as women meet a cloud of dust-she turned and looked backwards till he had passed.

This would have been disconcerting but for one reason: Christopher was ceasing to notice her. He was a man who often, when walking abroad, and looking as it were at the scene before his eyes, discerned successes and failures, friends and relations, episodes of childhood, wedding feasts and funerals, the landscape suffering greatly by these visions, until it became no more than the patterned wall-tints about the paintings in a gallery; something necessary to the tone, yet not regarded. Nothing but a special concentration of himself on externals could interrupt this habit, and now that her appearance along the way had changed from a chance to a custom he began to lapse again into the old trick. He gazed once or twice at her form without seeing it: he did not notice that she trembled.

He sometimes read as he walked, and book in hand he frequently approached her now. This went on till six weeks had passed from the time of their first encounter. Latterly might have been once or

twice heard, when he had moved out of earshot, a sound like a small gasping sigh; but no arrangements were disturbed, and Christopher continued to keep down his eyes as persistently as a saint in a church window.

The last day of his engagement had arrived, and with it the last of his walks that way. On his final return he carried in his hand a bunch of flowers which had been presented to him at the country-house where his lessons were given. He was taking them home to his sister Faith, who prized the lingering blossoms of the seeding season. Soon appeared as usual his fellow-traveller; whereupon Christopher looked down upon his nosegay. 'Sweet simple girl,' he thought, 'I'll endeavour to make peace with her by means of these flowers before we part for good.'

When she came up he held them out to her and said, 'Will you allow me to present you with these?'

The bright colours of the nosegay instantly attracted the girl's hand-perhaps before there had been time for thought to thoroughly construe the position; for it happened that when her arm was stretched into the air she steadied it quickly, and stood with the pose of a statue-rigid with uncertainty. But it was too late to refuse: Christopher had put the nosegay within her fingers. Whatever pleasant expression of thanks may have appeared in her eyes fell only on the bunch of flowers, for during the whole transaction they reached to no higher level than that. To say that he was coming no more seemed scarcely necessary under the circumstances, and wishing her 'Good afternoon' very heartily, he passed on.

He had learnt by this time her occupation, which was that of pupil-teacher at one of the schools in the town, whither she walked daily from a village near. If he had not been poor and the little teacher humble, Christopher might possibly have been tempted to inquire more briskly about her, and who knows how such a pursuit might have ended? But hard externals rule volatile sentiment, and under these untoward influences the girl and the book and the truth about its author were matters upon which he could not afford to expend much time. All Christopher did was to think now and then of the

pretty innocent face and round deep eyes, not once wondering if the mind which enlivened them ever thought of him.



3. SANDBOURNE MOOR (continued)

It was one of those hostile days of the year when chatterbox ladies remain miserably in their homes to save the carriage and harness, when clerks' wives hate living in lodgings, when vehicles and people appear in the street with duplicates of themselves underfoot, when bricklayers, slaters, and other out-door journeymen sit in a shed and drink beer, when ducks and drakes play with hilarious delight at their own family game, or spread out one wing after another in the slower enjoyment of letting the delicious moisture penetrate to their innermost down. The smoke from the flues of Sandbourne had barely strength enough to emerge into the drizzling rain, and hung down the sides of each chimney-pot like the streamer of a becalmed ship; and a troop of rats might have rattled down the pipes from roof to basement with less noise than did the water that day.

On the broad moor beyond the town, where Christopher's meetings with the teacher had so regularly occurred, were a stream and some large pools; and beside one of these, near some hatches and a weir, stood a little square building, not much larger inside than the Lord Mayor's coach. It was known simply as 'The Weir House.' On this wet afternoon, which was the one following the day of Christopher's last lesson over the plain, a nearly invisible smoke came from the puny chimney of the hut. Though the door was closed, sounds of chatting and mirth fizzed from the interior, and would have told anybody who had come near-which nobody did-that the usually empty shell was tenanted to-day.

The scene within was a large fire in a fireplace to which the whole floor of the house was no more than a hearthstone. The occupants were two gentlemanly persons, in shooting costume, who had been traversing the moor for miles in search of wild duck and teal, a waterman, and a small spaniel. In the corner stood their guns, and

two or three wild mallards, which represented the scanty product of their morning's labour, the iridescent necks of the dead birds replying to every flicker of the fire. The two sportsmen were smoking, and their man was mostly occupying himself in poking and stirring the fire with a stick: all three appeared to be pretty well wetted.

One of the gentlemen, by way of varying the not very exhilarating study of four brick walls within microscopic distance of his eye, turned to a small square hole which admitted light and air to the hut, and looked out upon the dreary prospect before him. The wide concave of cloud, of the monotonous hue of dull pewter, formed an unbroken hood over the level from horizon to horizon; beneath it, reflecting its wan lustre, was the glazed high-road which stretched, hedgeless and ditchless, past a directing-post where another road joined it, and on to the less regular ground beyond, lying like a riband unrolled across the scene, till it vanished over the furthest undulation. Beside the pools were occasional tall sheaves of flags and sedge, and about the plain a few bushes, these forming the only obstructions to a view otherwise unbroken.

The sportsman's attention was attracted by a figure in a state of gradual enlargement as it approached along the road.

'I should think that if pleasure can't tempt a native out of doors to-day, business will never force him out,' he observed. 'There is, for the first time, somebody coming along the road.'

'If business don't drag him out pleasure'll never tempt en, is more like our nater in these parts, sir,' said the man, who was looking into the fire.

The conversation showed no vitality, and down it dropped dead as before, the man who was standing up continuing to gaze into the moisture. What had at first appeared as an epicene shape the decreasing space resolved into a cloaked female under an umbrella: she now relaxed her pace, till, reaching the directing-post where the road branched into two, she paused and looked about her. Instead

of coming further she slowly retraced her steps for about a hundred yards.

'That's an appointment,' said the first speaker, as he removed the cigar from his lips; 'and by the lords, what a day and place for an appointment with a woman!'

'What's an appointment?' inquired his friend, a town young man, with a Tussaud complexion and well-pencilled brows half way up his forehead, so that his upper eyelids appeared to possess the uncommon quality of tallness.

'Look out here, and you'll see. By that directing-post, where the two roads meet. As a man devoted to art, Ladywell, who has had the honour of being hung higher up on the Academy walls than any other living painter, you should take out your sketch-book and dash off the scene.'

Where nothing particular is going on, one incident makes a drama; and, interested in that proportion, the art-sportsman puts up his eyeglass (a form he adhered to before firing at game that had risen, by which merciful arrangement the bird got safe off), placed his face beside his companion's, and also peered through the opening. The young pupil-teacher-for she was the object of their scrutiny-re-approached the spot whereon she had been accustomed for the last many weeks of her journey home to meet Christopher, now for the first time missing, and again she seemed reluctant to pass the hand-post, for that marked the point where the chance of seeing him ended. She glided backwards as before, this time keeping her face still to the front, as if trying to persuade the world at large, and her own shamefacedness, that she had not yet approached the place at all.

'Query, how long will she wait for him (for it is a man to a certainty)?' resumed the elder of the smokers, at the end of several minutes of silence, when, full of vacillation and doubt, she became lost to view behind some bushes. 'Will she reappear?' The smoking went on, and up she came into open ground as before, and walked by.

'I wonder who the girl is, to come to such a place in this weather? There she is again,' said the young man called Ladywell.

'Some cottage lass, not yet old enough to make the most of the value set on her by her follower, small as that appears to be. Now we may get an idea of the hour named by the fellow for the appointment, for, depend upon it, the time when she first came-about five minutes ago-was the time he should have been there. It is now getting on towards five-half-past four was doubtless the time mentioned.'

'She's not come o' purpose: 'tis her way home from school every day,' said the waterman.

'An experiment on woman's endurance and patience under neglect. Two to one against her staying a quarter of an hour.'

'The same odds against her not staying till five would be nearer probability. What's half-an-hour to a girl in love?'

'On a moorland in wet weather it is thirty perceptible minutes to any fireside man, woman, or beast in Christendom-minutes that can be felt, like the Egyptian plague of darkness. Now, little girl, go home: he is not worth it.'

Twenty minutes passed, and the girl returned miserably to the hand-post, still to wander back to her retreat behind the sedge, and lead any chance comer from the opposite quarter to believe that she had not yet reached this ultimate point beyond which a meeting with Christopher was impossible.

'Now you'll find that she means to wait the complete half-hour, and then off she goes with a broken heart.'

All three now looked through the hole to test the truth of the prognostication. The hour of five completed itself on their watches; the girl again came forward. And then the three in ambuscade could see her pull out her handkerchief and place it to her eyes.

'She's grieving now because he has not come. Poor little woman, what a brute he must be; for a broken heart in a woman means a broken vow in a man, as I infer from a thousand instances in

experience, romance, and history. Don't open the door till she is gone, Ladywell; it will only disturb her.'

As they had guessed, the pupil-teacher, hearing the distant town-clock strike the hour, gave way to her fancy no longer, and launched into the diverging path. This lingering for Christopher's arrival had, as is known, been founded on nothing more of the nature of an assignation than lay in his regular walk along the plain at that time every Monday, Wednesday, and Friday of the six previous weeks. It must be said that he was very far indeed from divining that his injudicious peace-offering of the flowers had stirred into life such a wearing, anxious, hopeful, despairing solicitude as this, which had been latent for some time during his constant meetings with the little stranger.

She vanished in the mist towards the left, and the loiterers in the hut began to move and open the door, remarking, 'Now then for Wyndway House, a change of clothes, and a dinner.'

4. SANDBOURNE PIER-ROAD TO WYNDWAY-BALL-ROOM IN WYNDWAY HOUSE

The last light of a winter day had gone down behind the houses of Sandbourne, and night was shut close over all. Christopher, about eight o'clock, was standing at the end of the pier with his back towards the open sea, whence the waves were pushing to the shore in frills and coils that were just rendered visible in all their bleak instability by the row of lights along the sides of the jetty, the rapid motion landward of the wavetips producing upon his eye an apparent progress of the pier out to sea. This pier-head was a spot which Christopher enjoyed visiting on such moaning and sighing nights as the present, when the sportive and variegated throng that haunted the pier on autumn days was no longer there, and he seemed alone with weather and the invincible sea.

Somebody came towards him along the deserted footway, and rays from the nearest lamp streaked the face of his sister Faith.

'O Christopher, I knew you were here,' she said eagerly. 'You are wanted; there's a servant come from Wyndway House for you. He is sent to ask if you can come immediately to play at a little dance they have resolved upon this evening-quite suddenly it seems. If you can come, you must bring with you any assistant you can lay your hands upon at a moment's notice, he says.'

'Wyndway House; why should the people send for me above all other musicians in the town?'

Faith did not know. 'If you really decide to go,' she said, as they walked homeward, 'you might take me as your assistant. I should answer the purpose, should I not, Kit? since it is only a dance or two they seem to want.'

'And your harp I suppose you mean. Yes; you might be competent to take a part. It cannot be a regular ball; they would have had the quadrille band for anything of that sort. Faith-we'll go. However, let us see the man first, and inquire particulars.'

Reaching home, Christopher found at his door a horse and wagonette in charge of a man-servant in livery, who repeated what Faith had told her brother. Wyndway House was a well-known country-seat three or four miles out of the town, and the coachman mentioned that if they were going it would be well that they should get ready to start as soon as they conveniently could, since he had been told to return by ten if possible. Christopher quickly prepared himself, and put a new string or two into Faith's harp, by which time she also was dressed; and, wrapping up herself and her instrument safe from the night air, away they drove at half-past nine.

'Is it a large party?' said Christopher, as they whizzed along.

'No, sir; it is what we call a dance-that is, 'tis like a ball, you know, on a small scale-a ball on a spurt, that you never thought of till you had it. In short, it grew out of a talk at dinner, I believe; and some of the young people present wanted a jig, and didn't care to play themselves, you know, young ladies being an idle class of society at the best of times. We've a house full of sleeping company, you understand-been there a week some of 'em-most of 'em being mistress's relations.'

'They probably found it a little dull.'

'Well, yes-it is rather dull for 'em-Christmas-time and all. As soon as it was proposed they were wild for sending post-haste for somebody or other to play to them.'

'Did they name me particularly?' said Christopher.

'Yes; "Mr. Christopher Julian," she says. "The gent who's turned music-man?" I said. "Yes, that's him," says she.'

'There were music-men living nearer to your end of the town than I.'

'Yes, but I know it was you particular: though I don't think mistress thought anything about you at first. Mr. Joyce-that's the

butler-said that your name was mentioned to our old party, when he was in the room, by a young lady staying with us, and mistress says then, "The Julians have had a downfall, and the son has taken to music." Then when dancing was talked of, they said, "O, let's have him by all means."

'Was the young lady who first inquired for my family the same one who said, "Let's have him by all means?"'

'O no; but it was on account of her asking that the rest said they would like you to play-at least that's as I had it from Joyce.'

'Do you know that lady's name?'

'Mrs. Petherwin.'

'Ah!'

'Cold, sir?'

'O no.'

Christopher did not like to question the man any further, though what he had heard added new life to his previous curiosity; and they drove along the way in silence, Faith's figure, wrapped up to the top of her head, cutting into the sky behind them like a sugar-loaf. Such gates as crossed the roads had been left open by the forethought of the coachman, and, passing the lodge, they proceeded about half-a-mile along a private drive, then ascended a rise, and came in view of the front of the mansion, punctured with windows that were now mostly lighted up.

'What is that?' said Faith, catching a glimpse of something that the carriage-lamp showed on the face of one wall as they passed, a marble bas-relief of some battle-piece, built into the stonework.

'That's the scene of the death of one of the squire's forefathers-Colonel Sir Martin Jones, who was killed at the moment of victory in the battle of Salamanca-but I haven't been here long enough to know the rights of it. When I am in one of my meditations, as I wait here with the carriage sometimes, I think how many more get killed at the moment of victory than at the moment of defeat. This is the

entrance for you, sir.' And he turned the corner and pulled up before a side door.

They alighted and went in, Christopher shouldering Faith's harp, and she marching modestly behind, with curly-eared music-books under her arm. They were shown into the house-steward's room, and ushered thence along a badly-lit passage and past a door within which a hum and laughter were audible. The door next to this was then opened for them, and they entered.

Scarcely had Faith, or Christopher either, ever beheld a more shining scene than was presented by the saloon in which they now found themselves. Coming direct from the gloomy park, and led to the room by that back passage from the servants' quarter, the light from the chandelier and branches against the walls, striking on gilding at all points, quite dazzled their sight for a minute or two; it caused Faith to move forward with her eyes on the floor, and filled Christopher with an impulse to turn back again into some dusky corner where every thread of his not over-new dress suit-rather moth-eaten through lack of feasts for airing it-could be counted less easily.

He was soon seated before a grand piano, and Faith sat down under the shadow of her harp, both being arranged on a dais within an alcove at one end of the room. A screen of ivy and holly had been constructed across the front of this recess for the games of the children on Christmas Eve, and it still remained there, a small creep-hole being left for entrance and exit.

Then the merry guests tumbled through doors at the further end, and dancing began. The mingling of black-coated men and bright ladies gave a charming appearance to the groups as seen by Faith and her brother, the whole spectacle deriving an unexpected novelty from the accident of reaching their eyes through interstices in the tracery of green leaves, which added to the picture a softness that it would not otherwise have possessed. On the other hand, the musicians, having a much weaker light, could hardly be discerned by the performers in the dance.

The music was now rattling on, and the ladies in their foam-like dresses were busily threading and spinning about the floor, when Faith, casually looking up into her brother's face, was surprised to see that a change had come over it. At the end of the quadrille he leant across to her before she had time to speak, and said quietly, 'She's here!'

'Who?' said Faith, for she had not heard the words of the coachman.

'Ethelberta.'

'Which is she?' asked Faith, peeping through with the keenest interest.

'The one who has the skirts of her dress looped up with convolvulus flowers-the one with her hair fastened in a sort of Venus knot behind; she has just been dancing with that perfumed piece of a man they call Mr. Ladywell-it is he with the high eyebrows arched like a girl's.' He added, with a wrinkled smile, 'I cannot for my life see anybody answering to the character of husband to her, for every man takes notice of her.'

They were interrupted by another dance being called for, and then, his fingers tapping about upon the keys as mechanically as fowls pecking at barleycorns, Christopher gave himself up with a curious and far from unalloyed pleasure to the occupation of watching Ethelberta, now again crossing the field of his vision like a returned comet whose characteristics were becoming purely historical. She was a plump-armed creature, with a white round neck as firm as a fort-altogether a vigorous shape, as refreshing to the eye as the green leaves through which he beheld her. She danced freely, and with a zest that was apparently irrespective of partners. He had been waiting long to hear her speak, and when at length her voice did reach his ears, it was the revelation of a strange matter to find how great a thing that small event had become to him. He knew the old utterance-rapid but not frequent, an obstructive thought causing sometimes a sudden halt in the midst of a stream of words. But the features by which a cool observer would have singled her

out from others in his memory when asking himself what she was like, was a peculiar gaze into imaginary far-away distance when making a quiet remark to a partner-not with contracted eyes like a seafaring man, but with an open full look-a remark in which little words in a low tone were made to express a great deal, as several single gentlemen afterwards found.

The production of dance-music when the criticizing stage among the dancers has passed, and they have grown full of excitement and animal spirits, does not require much concentration of thought in the producers thereof; and desultory conversation accordingly went on between Faith and her brother from time to time.

'Kit,' she said on one occasion, 'are you looking at the way in which the flowers are fastened to the leaves?-taking a mean advantage of being at the back of the tapestry? You cannot think how you stare at them.'

'I was looking through them-certainly not at them. I have a feeling of being moved about like a puppet in the hands of a person who legally can be nothing to me.'

'That charming woman with the shining bunch of hair and convolvuluses?'

'Yes: it is through her that we are brought here, and through her writing that poem, "Cancelled Words," that the book was sent me, and through the accidental renewal of acquaintance between us on Anglebury Heath, that she wrote the poem. I was, however, at the moment you spoke, thinking more particularly of the little teacher whom Ethelberta must have commissioned to send the book to me; and why that girl was chosen to do it.'

'There may be a hundred reasons. Kit, I have never yet seen her look once this way.'

Christopher had certainly not yet received look or gesture from her; but his time came. It was while he was for a moment outside the recess, and he caught her in the act. She became slightly confused, turned aside, and entered into conversation with a neighbour.

It was only a look, and yet what a look it was! One may say of a look that it is capable of division into as many species, genera, orders, and classes, as the animal world itself. Christopher saw Ethelberta Petherwin's performance in this kind-the well-known spark of light upon the well-known depths of mystery-and felt something going out of him which had gone out of him once before.

Thus continually beholding her and her companions in the giddy whirl, the night wore on with the musicians, last dances and more last dances being added, till the intentions of the old on the matter were thrice exceeded in the interests of the young. Watching the couples whirl and turn, advance and recede as gently as spirits, knot themselves like house-flies and part again, and lullabied by the faint regular beat of their footsteps to the tune, the players sank into the peculiar mesmeric quiet which comes over impressionable people who play for a great length of time in the midst of such scenes; and at last the only noises that Christopher took cognizance of were those of the exceptional kind, breaking above the general sea of sound-a casual smart rustle of silk, a laugh, a stumble, the monosyllabic talk of those who happened to linger for a moment close to the leafy screen-all coming to his ears like voices from those old times when he had mingled in similar scenes, not as servant but as guest.

5. AT THE WINDOW-THE ROAD HOME

The dancing was over at last, and the radiant company had left the room. A long and weary night it had been for the two players, though a stimulated interest had hindered physical exhaustion in one of them for a while. With tingling fingers and aching arms they came out of the alcove into the long and deserted apartment, now pervaded by a dry haze. The lights had burnt low, and Faith and her brother were waiting by request till the wagonette was ready to take them home, a breakfast being in course of preparation for them meanwhile.

Christopher had crossed the room to relieve his cramped limbs, and now, peeping through a crevice in the window curtains, he said suddenly, 'Who's for a transformation scene? Faith, look here!'

He touched the blind, up it flew, and a gorgeous scene presented itself to her eyes. A huge inflamed sun was breasting the horizon of a wide sheet of sea which, to her surprise and delight, the mansion overlooked. The brilliant disc fired all the waves that lay between it and the shore at the bottom of the grounds, where the water tossed the ruddy light from one undulation to another in glares as large and clear as mirrors, incessantly altering them, destroying them, and creating them again; while further off they multiplied, thickened, and ran into one another like struggling armies, till they met the fiery source of them all.

'O, how wonderful it is!' said Faith, putting her hand on Christopher's arm. 'Who knew that whilst we were all shut in here with our puny illumination such an exhibition as this was going on outside! How sorry and mean the grand and stately room looks now!'

Christopher turned his back upon the window, and there were the hitherto beaming candle-flames shining no more radiantly than tarnished javelin-heads, while the snow-white lengths of wax showed themselves clammy and cadaverous as the fingers of a corpse. The leaves and flowers which had appeared so very green and blooming by the artificial light were now seen to be faded and dusty. Only the gilding of the room in some degree brought itself into keeping with the splendours outside, stray darts of light seizing upon it and lengthening themselves out along fillet, quirk, arris, and moulding, till wasted away.

'It seems,' said Faith, 'as if all the people who were lately so merry here had died: we ourselves look no more than ghosts.' She turned up her weary face to her brother's, which the incoming rays smote aslant, making little furrows of every wrinkle thereon, and shady ravines of every little furrow.

'You are very tired, Faith,' he said. 'Such a heavy night's work has been almost too much for you.'

'O, I don't mind that,' said Faith. 'But I could not have played so long by myself.'

'We filled up one another's gaps; and there were plenty of them towards the morning; but, luckily, people don't notice those things when the small hours draw on.'

'What troubles me most,' said Faith, 'is not that I have worked, but that you should be so situated as to need such miserable assistance as mine. We are poor, are we not, Kit?'

'Yes, we know a little about poverty,' he replied.

While thus lingering

'In shadowy thoroughfares of thought,'

Faith interrupted with, 'I believe there is one of the dancers now!-why, I should have thought they had all gone to bed, and wouldn't get up again for days.' She indicated to him a figure on the lawn towards the left, looking upon the same flashing scene as that they themselves beheld.

'It is your own particular one,' continued Faith. 'Yes, I see the blue flowers under the edge of her cloak.'

'And I see her squirrel-coloured hair,' said Christopher.

Both stood looking at this apparition, who once, and only once, thought fit to turn her head towards the front of the house they were gazing from. Faith was one in whom the meditative somewhat overpowered the active faculties; she went on, with no abundance of love, to theorize upon this gratuitously charming woman, who, striking freakishly into her brother's path, seemed likely to do him no good in her sisterly estimation. Ethelberta's bright and shapely form stood before her critic now, smartened by the motes of sunlight from head to heel: what Faith would have given to see her so clearly within!

'Without doubt she is already a lady of many romantic experiences,' she said dubiously.

'And on the way to many more,' said Christopher. The tone was just of the kind which may be imagined of a sombre man who had been up all night piping that others might dance.

Faith parted her lips as if in consternation at possibilities. Ethelberta, having already become an influence in Christopher's system, might soon become more-an indestructible fascination-to drag him about, turn his soul inside out, harrow him, twist him, and otherwise torment him, according to the stereotyped form of such processes.

They were interrupted by the opening of a door. A servant entered and came up to them.

'This is for you, I believe, sir,' he said. 'Two guineas;' and he placed the money in Christopher's hand. 'Some breakfast will be ready for you in a moment if you like to have it. Would you wish it brought in here; or will you come to the steward's room?'

'Yes, we will come.' And the man then began to extinguish the lights one by one. Christopher dropped the two pounds and two shillings singly into his pocket, and looking listlessly at the footman

said, 'Can you tell me the address of that lady on the lawn? Ah, she has disappeared!'

'She wore a dress with blue flowers,' said Faith.

'And remarkable bright in her manner? O, that's the young widow, Mrs-what's that name-I forget for the moment.'

'Widow?' said Christopher, the eyes of his understanding getting wonderfully clear, and Faith uttering a private ejaculation of thanks that after all no commandments were likely to be broken in this matter. 'The lady I mean is quite a girlish sort of woman.'

'Yes, yes, so she is-that's the one. Coachman says she must have been born a widow, for there is not time for her ever to have been made one. However, she's not quite such a chicken as all that. Mrs. Petherwin, that's the party's name.'

'Does she live here?'

'No, she is staying in the house visiting for a few days with her mother-in-law. They are a London family, I don't know her address.'

'Is she a poetess?'

'That I cannot say. She is very clever at verses; but she don't lean over gates to see the sun, and goes to church as regular as you or I, so I should hardly be inclined to say that she's the complete thing. When she's up in one of her vagaries she'll sit with the ladies and make up pretty things out of her head as fast as sticks a-breaking. They will run off her tongue like cotton from a reel, and if she can ever be got in the mind of telling a story she will bring it out that serious and awful that it makes your flesh creep upon your bones; if she's only got to say that she walked out of one door into another, she'll tell it so that there seems something wonderful in it. 'Tis a bother to start her, so our people say behind her back, but, once set going, the house is all alive with her. However, it will soon be dull enough; she and Lady Petherwin are off to-morrow for Rookington, where I believe they are going to stay over New Year's Day.'

'Where do you say they are going?' inquired Christopher, as they followed the footman.

'Rookington Park-about three miles out of Sandbourne, in the opposite direction to this.'

'A widow,' Christopher murmured.

Faith overheard him. 'That makes no difference to us, does it?' she said wistfully.

Forty minutes later they were driving along an open road over a ridge which commanded a view of a small inlet below them, the sands of this nook being sheltered by crumbling cliffs. Here at once they saw, in the full light of the sun, two women standing side by side, their faces directed over the sea.

'There she is again!' said Faith. 'She has walked along the shore from the lawn where we saw her before.'

'Yes,' said the coachman, 'she's a curious woman seemingly. She'll talk to any poor body she meets. You see she had been out for a morning walk instead of going to bed, and that is some queer mortal or other she has picked up with on her way.'

'I wonder she does not prefer some rest,' Faith observed.

The road then dropped into a hollow, and the women by the sea were no longer within view from the carriage, which rapidly neared Sandbourne with the two musicians.

6. THE SHORE BY WYNDWAY

The east gleamed upon Ethelberta's squirrel-coloured hair as she said to her companion, 'I have come, Picotee; but not, as you imagine, from a night's sleep. We have actually been dancing till daylight at Wyndway.'

'Then you should not have troubled to come! I could have borne the disappointment under such circumstances,' said the pupil-teacher, who, wearing a dress not so familiar to Christopher's eyes as had been the little white jacket, had not been recognized by him from the hill. 'You look so tired, Berta. I could not stay up all night for the world!'

'One gets used to these things,' said Ethelberta quietly. 'I should have been in bed certainly, had I not particularly wished to use this opportunity of meeting you before you go home to-morrow. I could not have come to Sandbourne to-day, because we are leaving to return again to Rookington. This is all that I wish you to take to mother-only a few little things which may be useful to her; but you will see what it contains when you open it.' She handed to Picotee a small parcel. 'This is for yourself,' she went on, giving a small packet besides. 'It will pay your fare home and back, and leave you something to spare.'

'Thank you,' said Picotee docilely.

'Now, Picotee,' continued the elder, 'let us talk for a few minutes before I go back: we may not meet again for some time.' She put her arm round the waist of Picotee, who did the same by Ethelberta; and thus interlaced they walked backwards and forwards upon the firm flat sand with the motion of one body animated by one will.

'Well, what did you think of my poems?'

'I liked them; but naturally, I did not understand all the experience you describe. It is so different from mine. Yet that made them more

interesting to me. I thought I should so much like to mix in the same scenes; but that of course is impossible.'

'I am afraid it is. And you posted the book as I said?'

'Yes.' She added hurriedly, as if to change the subject, 'I have told nobody that we are sisters, or that you are known in any way to me or to mother or to any of us. I thought that would be best, from what you said.'

'Yes, perhaps it is best for the present.'

'The box of clothes came safely, and I find very little alteration will be necessary to make the dress do beautifully for me on Sundays. It is quite new-fashioned to me, though I suppose it was old-fashioned to you. O, and Berta, will the title of Lady Petherwin descend to you when your mother-in-law dies?'

'No, of course not. She is only a knight's widow, and that's nothing.'

'The lady of a knight looks as good on paper as the lady of a lord.'

'Yes. And in other places too sometimes. However, about your journey home. Be very careful; and don't make any inquiries at the stations of anybody but officials. If any man wants to be friendly with you, try to find out if it is from a genuine wish to assist you, or from admiration of your fresh face.'

'How shall I know which?' said Picotee.

Ethelberta laughed. 'If Heaven does not tell you at the moment I cannot,' she said. 'But humanity looks with a different eye from love, and upon the whole it is most to be prized by all of us. I believe it ends oftener in marriage than do a lover's flying smiles. So that for this and other reasons love from a stranger is mostly worthless as a speculation; and it is certainly dangerous as a game. Well, Picotee, has any one paid you real attentions yet?'

'No-that is-'

'There is something going on.'

'Only a wee bit.'

'I thought so. There was a dishonesty about your dear eyes which has never been there before, and love-making and dishonesty are inseparable as coupled hounds. Up comes man, and away goes innocence. Are you going to tell me anything about him?'

'I would rather not, Ethelberta; because it is hardly anything.'

'Well, be careful. And mind this, never tell him what you feel.'

'But then he will never know it.'

'Nor must he. He must think it only. The difference between his thinking and knowing is often the difference between your winning and losing. But general advice is not of much use, and I cannot give more unless you tell more. What is his name?'

Picotee did not reply.

'Never mind: keep your secret. However, listen to this: not a kiss-not so much as the shadow, hint, or merest seedling of a kiss!'

'There is no fear of it,' murmured Picotee; 'though not because of me!'

'You see, my dear Picotee, a lover is not a relative; and he isn't quite a stranger; but he may end in being either, and the way to reduce him to whichever of the two you wish him to be is to treat him like the other. Men who come courting are just like bad cooks: if you are kind to them, instead of ascribing it to an exceptional courtesy on your part, they instantly set it down to their own marvellous worth.'

'But I ought to favour him just a little, poor thing? Just the smallest glimmer of a gleam!'

'Only a very little indeed-so that it comes as a relief to his misery, not as adding to his happiness.'

'It is being too clever, all this; and we ought to be harmless as doves.'

'Ah, Picotee! to continue harmless as a dove you must be wise as a serpent, you'll find-ay, ten serpents, for that matter.'

'But if I cannot get at him, how can I manage him in these ways you speak of?'

'Get at him? I suppose he gets at you in some way, does he not?-tries to see you, or to be near you?'

'No-that's just the point-he doesn't do any such thing, and there's the worry of it!'

'Well, what a silly girl! Then he is not your lover at all?'

'Perhaps he's not. But I am his, at any rate-twice over.'

'That's no use. Supply the love for both sides? Why, it's worse than furnishing money for both. You don't suppose a man will give his heart in exchange for a woman's when he has already got hers for nothing? That's not the way old Adam does business at all.'

Picotee sighed. 'Have you got a young man, too, Berta?'

'A young man?'

'A lover I mean-that's what we call 'em down here.'

'It is difficult to explain,' said Ethelberta evasively. 'I knew one many years ago, and I have seen him again, and-that is all.'

'According to my idea you have one, but according to your own you have not; he does not love you, but you love him-is that how it is?'

'I have not quite considered how it is.'

'Do you love him?'

'I have never seen a man I hate less.'

'A great deal lies covered up there, I expect!'

'He was in that carriage which drove over the hill at the moment we met here.'

'Ah-ah-some great lord or another who has his day by candlelight, and so on. I guess the style. Somebody who no more knows how much bread is a loaf than I do the price of diamonds and pearls.'

'I am afraid he's only a commoner as yet, and not a very great one either. But surely you guess, Picotee? But I'll set you an example of frankness by telling his name. My friend, Mr. Julian, to whom you posted the book. Such changes as he has seen!-from affluence to

poverty. He and his sister have been playing dances all night at Wyndway-What is the matter?'

'Only a pain!'

'My dear Picotee-'

'I think I'll sit down for a moment, Berta.'

'What-have you over-walked yourself, dear?'

'Yes-and I got up very early, you see.'

'I hope you are not going to be ill, child. You look as if you ought not to be here.'

'O, it is quite trifling. Does not getting up in a hurry cause a sense of faintness sometimes?'

'Yes, in people who are not strong.'

'If we don't talk about being faint it will go off. Faintness is such a queer thing that to think of it is to have it. Let us talk as we were talking before-about your young man and other indifferent matters, so as to divert my thoughts from fainting, dear Berta. I have always thought the book was to be forwarded to that gentleman because he was a connection of yours by marriage, and he had asked for it. And so you have met this-this Mr. Julian, and gone for walks with him in evenings, I suppose, just as young men and women do who are courting?'

'No, indeed-what an absurd child you are!' said Ethelberta. 'I knew him once, and he is interesting; a few little things like that make it all up.'

'The love is all on one side, as with me.'

'O no, no: there is nothing like that. I am not attached to any one, strictly speaking-though, more strictly speaking, I am not unattached.'

'Tis a delightful middle mind to be in. I know it, for I was like it once; but I had scarcely been so long enough to know where I was before I was gone past.'

'You should have commanded yourself, or drawn back entirely; for let me tell you that at the beginning of caring for a man-just when

you are suspended between thinking and feeling-there is a hair's-breadth of time at which the question of getting into love or not getting in is a matter of will-quite a thing of choice. At the same time, drawing back is a tame dance, and the best of all is to stay balanced awhile.'

'You do that well, I'll warrant.'

'Well, no; for what between continually wanting to love, to escape the blank lives of those who do not, and wanting not to love, to keep out of the miseries of those who do, I get foolishly warm and foolishly cold by turns.'

'Yes-and I am like you as far as the "foolishly" goes. I wish we poor girls could contrive to bring a little wisdom into our love by way of a change!'

'That's the very thing that leading minds in town have begun to do, but there are difficulties. It is easy to love wisely, but the rich man may not marry you; and it is not very hard to reject wisely, but the poor man doesn't care. Altogether it is a precious problem. But shall we clamber out upon those shining blocks of rock, and find some of the little yellow shells that are in the crevices? I have ten minutes longer, and then I must go.'

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